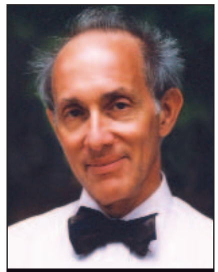
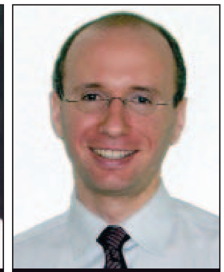
Guest Editorial

Embedded in Nature: Human Health and Biodiversity



Eric Chivian



Aaron S. Bernstein

A loss of global biodiversity, namely a reduction in the variety of life on Earth, is rarely given much attention by physicians or environmental scientists. Like most people, they do not spend much time thinking about their relationship to other life forms, and they generally act, unknowingly, as if human beings were separate from the rest of nature—as if we could change the composition of the atmosphere and degrade the land and the oceans without these alterations having much effect on us. It is this disconnect that is at the core of the global environmental crisis—that policy makers and the public by and large do not understand that their health and lives are ultimately dependent on other species and on the integrity of the planet's ecosystems, and, as a result, they do not appreciate the urgent need to protect the natural world.

Approximately 1.7 million species have been identified on Earth and given Linnaean names (United Nations Environment Programme 1996), but there may be 10 times that number in all, and perhaps many times more if we include microbial diversity (Pimm et al. 1995). Species interact with each other and with their physical and chemical environments to make up ecosystems such as forests and wetlands. Stratospheric ozone depletion, pollution, the introduction of alien species, the overharvesting of species, and increasingly global climate change (Walther et al. 2002) all threaten biodiversity and thus ecosystem function. However, the degradation, reduction, and fragmentation of habitats on land, in fresh water, and in the oceans are the greatest threats (Pimm and Raven 2000). All of these factors are the result of human activity and are driven by unsustainable consumption, especially in the industrialized world, and rising human populations. Together they have disrupted grassland, river, lake, coral reef, and other ecosystems at alarming levels, and have raised the rate of species extinctions to 100 and, by some estimates, even to 1,000 times natural background rates (Pimm et al.1995).

The loss of species deprives us of invaluable tools for biomedical research that provide insights into how human cells and organ systems function in health and illness, and precludes our developing important new medicines for currently untreatable human diseases. Cone snails, a large genus of some 500 species that live mostly in tropical coral reefs and mangroves, are a case in point. These remarkable creatures capture their prey by lancing them with a harpoon coated with a cocktail of toxic peptides, which bind to an enormous variety of ion channels and receptors on cellular membranes throughout the animal kingdom (Olivera et al. 1990). Each species may make as many as 100 distinct toxins, so there may be as many as 50,000 different ones in all (Olivera 1990). One hundred or so of these toxins have been studied to date and have demonstrated such selectivity for specific receptors that some have been used, for example, to help characterize subtypes of nicotinic acetylcholine receptors in mammalian heart muscle, leading to a better understanding of the mechanisms that control heart rate and contractility (Bibevski et al. 2000). Others are being developed as medicines, including a painkiller possibly 1,000 times more potent than morphine but that does not cause tolerance or addiction (Bowersox et al. 1996). This painkiller may soon come on the market in Europe for the treatment of severe, chronic pain, a condition that often defies treatment with opiates such as morphine because of tolerance. Other cone snail toxins are being investigated for treating intractable epilepsy (McIntsosh et al. 2001), for preventing nerve cell death when there is inadequate circulation (Williams et al. 2002), and for the early diagnosis and treatment of small cell carcinomas of the lung, one of the most aggressive human cancers (Codignola et al. 1996; Sher et al. 2000). Cone snails may contain the largest and most clinically important pharmacopoeia of any genus in nature, and yet, as coral reefs and mangroves are in danger of being destroyed, so are they (Chivian et al. 2003).

The importance of biodiversity to human health is particularly well illustrated by some human infectious diseases. Lyme disease, the most common vectorborne disease in the United States, is a prime example. When high levels of vertebrate-species diversity exist in a Lyme disease area, the risk of getting Lyme disease is lessened. One reason is that some of the vertebrates that are bitten by infected ticks, the vectors which transmit the Lyme bacteria, are "dead end" hosts—poorly able or incapable of passing on the bacteria and continuing the disease cycle. This effectively "dilutes" the disease agent and makes it less likely for an infected tick to transmit the disease to a human (Ostfeld and Keesing 2000a). Another reason this diversity is beneficial is that some vertebrate species compete with the main Lyme reservoir host or carrier (the white-footed mouse in the eastern United States), whereas others are predators—in both cases keeping mice populations low and reducing disease risk. This buffering effect conferred by biodiversity may also apply to other human infectious diseases such as West Nile encephalitis, cutaneous and visceral leishmaniasis, African trypanosomiasis, and Chagas disease (Ostfeld and Keesing 2000b).

Finally, and most importantly, ecosystems provide the life support systems for all life, including human life, on Earth. Not only do they give us food and fuel, but ecosystems, among other things, purify air and fresh water, bind and detoxify poisonous substances, break down wastes and recycle nutrients on land and in the oceans, pollinate crops and natural vegetation, make soils fertile, and store carbon, mitigating human-caused climate change (Melillo and Sala 2002). We tend to take these services for granted and generally do not recognize that we cannot live without them. Nor do we understand many ecosystem services well enough to recreate them, not knowing what species are necessary for the services to work and in what proportions, or whether for some services there are essential or "keystone" species without which ecosystems would cease to function. Human activity may now be altering some ecosystems in destructive ways that we are unaware of and that could lead to a collapse of their functioning.

The importance of recognizing how biodiversity affects human health and how it is increasingly threatened by human activity will only increase in coming years. Physicians and environmental scientists will need to understand these interconnections because they will be called upon to explain them to policy makers and the public. Such knowledge will also be critically important in clinical medicine, particularly in relation to the emergence and spread of some human infectious diseases. Our center and others, such as the Consortium for Conservation Medicine, are working to better understand how human health depends on the health of other species and on the natural functioning of healthy ecosystems, and to help disseminate this understanding more widely.

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Editorial

EHP Moves to Open Access


Kenneth Olden


Thomas J. Goehl

Last month, we announced that *EHP* would become an open access journal. That promise is now a reality. The Internet affords us a unique opportunity to enhance scientific discourse. Therefore, all research articles are now freely accessible on our website (http://www.ehponline.org/) immediately upon acceptance following a demanding peer-review process. Also, all archival research content and current news and announcements are now freely available. We are finalizing arrangements to conform to another essential feature of the open access model by depositing *EHP*'s research content into a public digital library archive where the material will be permanently preserved and freely available for search and retrieval; we have chosen to use PubMed Central.

Be assured that *EHP*'s conversion to an open access journal will not affect the high quality that is expected of articles published in *EHP*. We will maintain our rigorous peer-review process, editorial oversight, and high production standards. Coinciding with the conversion to open access, We have also expanded and updated our website, which houses over 10,000 archived research articles. This expansion makes material more easily accessible for an expected large increase in the number of visitors.

The struggle for open access to scientific literature has been a long one and is ongoing. Some of the innovative work on the road to open access included Paul Ginsparg's launch in 1991 of arXiv.org e-Print archive (http://arxiv.org/), an Internet server for posting preprints of high-energy physics research articles with free access to all researchers. Another important step occurred in 1995, when the *British Medical Journal* became the first medical journal to provide free access to full text of all its articles (http://bmj.bmjjournals.com/).

In 1999, Harold Varmus developed plans for a National Library of Medicine digital archive to improve access to scientific literature, in the hope that journals would make content available to this digital archive without restrictions. In 2000, this archive, now known as PubMed Central (http://www.pubmedcentral.nih.gov/), became a reality, with some content provided by *Proceedings of the National Academy of Sciences* and *Molecular Biology of the Cell*. However, the timeliness of the deposition of published articles into PubMed Central remains an issue.

The open access philosophy was formalized at a meeting of scientific editors and publishers held in Budapest in December 2001 and organized by the Open Society Institute, a foundation seeking to further the open access paradigm (http://www.soros.org/initiatives/information/focus_areas/openaccess). A consensus statement from that meeting, called the Budapest Open Access Initiative, laid out the goals and issues involved in providing peer-reviewed scientific literature on the Internet without restriction. The statement (http://www.soros.org/openaccess/read.shtml) says in part,

> Removing access barriers to this literature will accelerate research, enrich education, share the learning of the rich with the poor and the poor with the rich, make this literature as useful as it can be, and lay the foundation for uniting humanity in a common intellectual conversation and quest for knowledge.

The benefits of open access were not lost on the commercial sector, and in 2000, BioMed Central (BMC) was initiated as a commercial venture to publish open access research articles in a series of new BMC journals (http://www.biomedcentral.com/). BMC's business model requires author funding, and there is a charge for print subscriptions.

In 2001, a nonprofit organization was formed to publish another group of open access journals that would compete with the highest-ranking journals; these journals would become known collectively as the Public Library of Science (PLoS; http://www.publiclibraryofscience.org/). The first issue of the first journal, *PLoS Biology*, was published in October 2003. PloS's business model is also based on author funding and paid print subscriptions.

Other journals are considering open access. For example, Oxford University Press is experimenting with open access for its journal *Nucleic Acid Research* (http://www3.oup.co.uk/nar/special/14/default.html). Oxford University Press will use an author-funded publishing model for the annual "Database Issue" published in January 2004. If that first step proves successful, the rest of the journal would gradually move to an open access model over the next 4–5 years.

Funding is always a question when open access is discussed. The National Institute of Environmental Health Sciences has decided that adequate resources will be made available to help offset initial revenue loss. We anticipate that taxpayer funding will decrease as we gradually switch to an author-funded business model, and we will maintain our print subscription service.

Converting to an open access model is also part of efforts by *EHP* to reach out to an international audience. *EHP* currently provides complimentary print copies of the journal to institutions in developing countries, and recently *EHP* began posting online translations of article summaries in Chinese, French, Japanese, Russian, and Spanish (http://ehpnet1.niehs.nih.gov/docs/iti.html). We are committed to doing everything we can to allow the cutting-edge environmental health research published in our journal to benefit people across the globe.

After carefully considering various scientific publishing models, we have concluded that the rationale behind the open access philosophy—that science best benefits society when it is freely and immediately available to all—is too compelling to ignore. As part of the U.S. government, we feel it is incumbent on us to take a leadership role in this area. We invite all *EHP* readers to take full advantage of this new accessibility, and we strongly encourage you to share this resource with your colleagues around the world. The more we know and the more we share, the more progress we can make toward environmental health for all.

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